



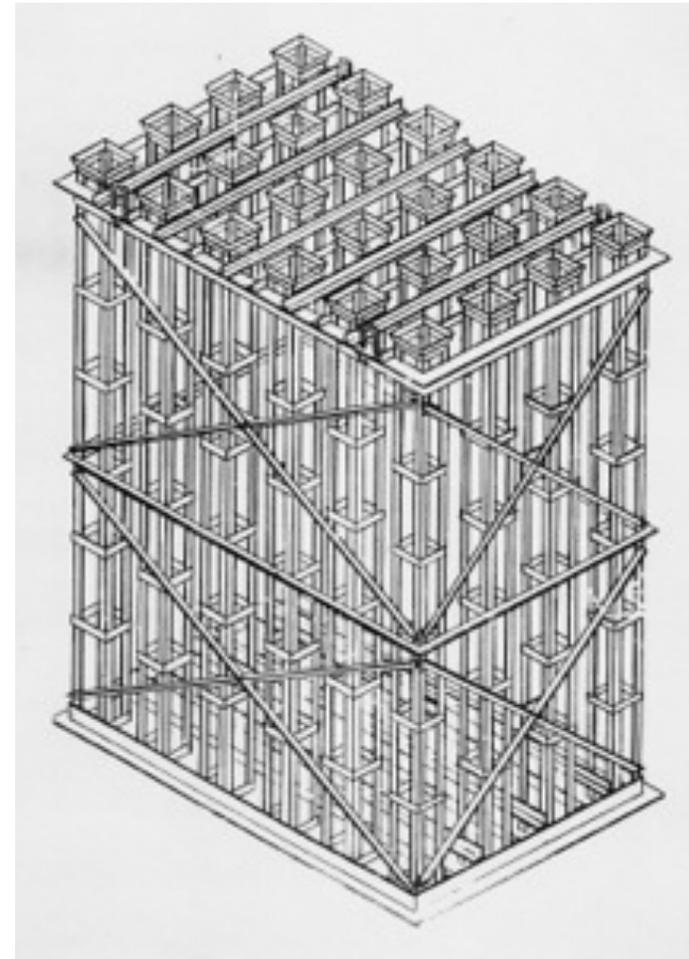
**NRC Commissioners' Briefing on
Spent Fuel Pool Safety and Consideration of
Expedited Transfer of Spent Fuel to Dry Casks
* Rockville, MD, 6 January 2014 ***

“Imperatives for Expedited Transfer”

A presentation by Gordon Thompson

Low-Density, Open-Frame Rack for Storing Spent Fuel (PWR)

- Criticality is suppressed by geometry
- If water is lost, fuel will be cooled by 3-D convective circulation of air and steam
- Spent fuel is passively protected against zirc. self-ignition across a broad range of water-loss scenarios



Modes of Water Loss from a Spent-Fuel Pool

Mode of Water Loss	Relevant to Accidents?	Relevant to Attacks?
Sloshing	Yes*	Yes
Displacement	Yes	Yes
Tipping of pool	Yes	Yes
Siphoning or Pumping	No	Yes
Boiling	Yes	Yes
Leakage	Yes*	Yes

* Modes considered by NRC Staff, but only for earthquake initiation

“Severe Reference” Case for Water Loss

- This case represents many water-loss scenarios
- Could proceed to zirc.-steam ignition
- Paks-2 accident in 2003 provides a partial analog
- NRC refuses to study this case

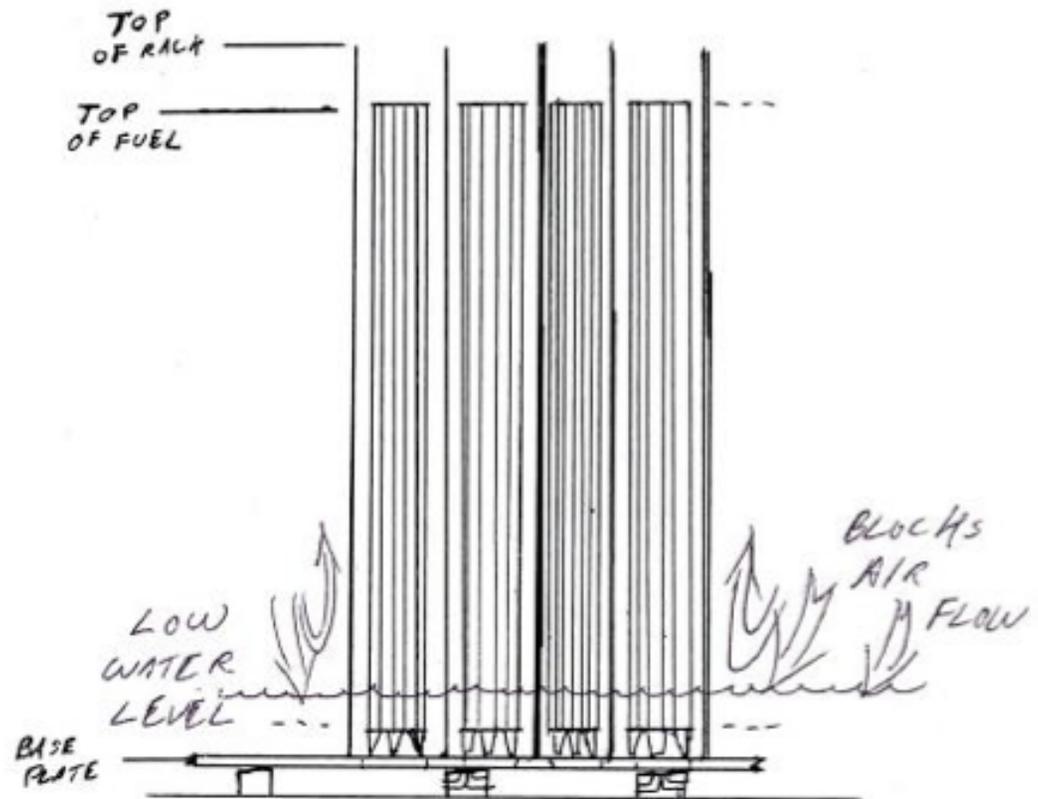


Figure from: Braun, 2010.

Ignition Delay Time in Severe Reference Case (PWR fuel)

Fuel Age	Ignition Delay Time
10 days	1.4 hours
100 days	3.9 hours
1,000 days	21 hours

Notes:

- (a) Here, ignition delay time (IDT) = time required for decay heat to raise fuel temp. from 100°C to 1,000°C under adiabatic conditions, for a fuel burnup of 50 GWt-days per Mg U.
- (b) IDT is 30% higher for BWR fuel (with channel boxes).

Onsite Radiation Field Created by a Reactor Release: An Illustrative Case

Indicator	Av. Over 1 Day	Av. Over 7 Days
Dose rate	44 Sv/hr	18 Sv/hr
Time to accrue median lethal dose (3 Sv)	4 minutes	10 minutes

Notes:

- (a) This case assumes uniform distribution, across a circle of 200 m radius, of 10% of I and Cs, and 5% of Te, in the core of a 2910 MWt reactor.
- (b) Radiation dose is whole-body groundshine without shielding.
- (c) Calculations are in a Nov. 2000 report by Gordon Thompson.

Some Outcomes Associated with Atmospheric Release of Cs-137

Actual Releases

- Chernobyl (85 PBq): “Perhaps the real cause of the collapse of the Soviet Union” (Gorbachev, 2006)
- Fukushima (36 PBq released; 6 PBq fallout on Japan): Displacement of 160,000 people; all nuclear power plants in Japan currently shut down

Potential Releases

- Peach Bottom (330 PBq): Long-term displacement of 4.1 million people (NRC average case)
- Dampierre (100 PBq): Economic damage of \$0.4 trillion to \$8.1 trillion; “an unmanageable European catastrophe” (IRSN studies)

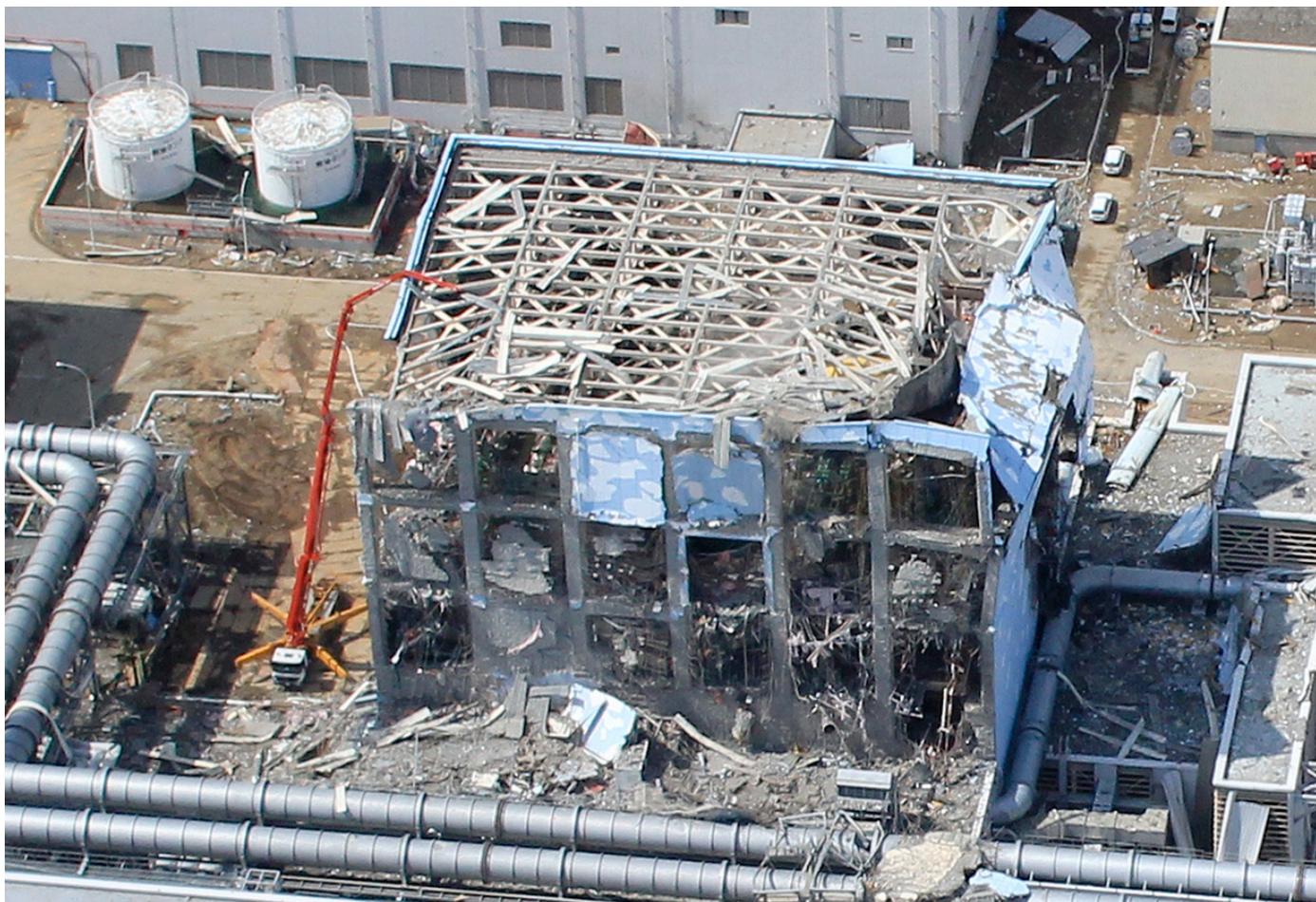
Some Inventories of Cs-137

Peach Bottom Pool: (One of two neighboring pools)	2,200 PBq
Fukushima #1 Unit 4 Pool:	1,100 PBq
Fukushima #1 Unit 3 Reactor:	350 PBq
Dry Cask (32 PWR assemblies):	67 PBq
Fukushima Fallout on Japan:	6 PBq

Some Observations About Radiological Risk

- The statement: “risk = (probability)x(consequences)” is ideology, NOT science
- If consequences could be severe, an appropriate indicator of probability would be the number of occurrences per century across all US facilities
- Qualitative factors could be major determinants of probability and consequences
- NRC’s consideration of pool fires has focused on rapid, total loss of water; this is a reprise of a 1960s focus on large-break LOCAs, which warped reactor design

A Wake-Up Call: Fukushima #1 Unit 4



Some Observations About Reverting to Low-Density, Open-Frame Racks

- The major driver of cost would be the transfer of excess spent fuel to dry casks
- This transfer will occur anyway, after reactors are shut down
- Thus, the incremental cost of acting now is simply the time value of the transfer cost
- Presence of high-burnup fuel could increase transfer cost; this is symptomatic of larger problems with high-burnup fuel

Conclusions

- NRC should order the rapid reversion of all pools to low-density, open-frame racks
- NRC should scrap the Staff's pool-fire study and Tier 3 analysis
- NRC should sponsor a thorough, open, science-based inquiry into phenomena related to pool (and cask) fires, including pool-reactor risk linkages
- NRC should seek to internationalize the inquiry, in view of pool hazards elsewhere (e.g., La Hague)